Industrial processing of insects

- Innovative solutions to improve processing
What we’ll talk about today

- Agenda

Global challenges ahead
- Population growth and protein demand
- Insects to fill growing demand for global protein
- Trends in insect processing

Process solutions
- Entire process – from feed preparation and rearing to processing, drying and packing
- Larvae processing options

Partnership
- Alfa Laval: separation, heat and fluid transfer experts
- Bühler Insect Technology Solutions: total solution provider
- Solutions for any insect breeder
Challenges of the global food industry

1/3 of the food produced is wasted

10 billion people by 2050

Source: Bühler Insect Technology Solutions
Global protein challenge
- 50% increase in protein demand by 2050

- Farm
  - 2015: 525 million tons primary proteins
  - 2050: +265 million tons (50% increase)

- Fork
  - 2015: 7.4 billion people
  - 2050: +2.3 billion

- Food
  - Today: 25% of global protein
  - 2050: 15% of global protein

- Feed
  - Today: Limited availability and high price volatility
  - 2015: +265 million tons primary proteins

- Meat consumption
  - Today: 25%
  - 2050: +50%

- Arable land
  - Today: 85% in use
  - 2050: 50% in use

- Animal conversion
  - Today: 15%
  - 2050: 45%

Source: Bühler Insect Technology Solutions
Why insects?
- Solving global protein and waste challenges

Source: Bühler Insect Technology Solutions
Why insects?
- Solving global protein and waste challenges

Insect proteins can be produced locally.

They are the natural diet of many animals.

Production with little environmental impact

- Land use (m²): Chicken 51, Black soldier fly larvae 4
- Water use (m³): Chicken 34, Black soldier fly larvae 5
- CO₂-equivalent (kg): Chicken 33, Black soldier fly larvae 6
- Energy use (kJ): Chicken 120, Black soldier fly larvae 80

Impact on the environment per kilogram of protein
Why insects?
- Solving global protein and waste challenges

- Flexible on what they eat
  - transform large variety of feedstock

- Very fast growth cycle
  - allows efficient production

- High nutrient accumulation
  - rich in proteins, lipids, and minerals

- Naturally in high densities
  - suitable for mass rearing
Insect market view
- Large market potential, investments are increasing

>420 MUSD have been invested in the industry!

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Total funds raised (million USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ynsect</td>
<td>France</td>
<td>150</td>
</tr>
<tr>
<td>Agriprotein</td>
<td>South Africa</td>
<td>122</td>
</tr>
<tr>
<td>InnovaFeed</td>
<td>France</td>
<td>62</td>
</tr>
<tr>
<td>Protix</td>
<td>Netherlands</td>
<td>50</td>
</tr>
<tr>
<td>BioflyTech</td>
<td>Spain</td>
<td>18</td>
</tr>
<tr>
<td>Enterra</td>
<td>Canada</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: Lux Research, 2018
Global protein challenge

- Fishmeal supply is drying up

Source: Bühler Insect Technology Solutions
## Trends in insect processing

### Feedstock options

<table>
<thead>
<tr>
<th>Agricultural residues</th>
<th>Industrial by-products</th>
<th>Retail discards</th>
<th>Residential waste</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accepted</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Fruit and vegetable leftovers</td>
<td>• Brewer’s spent grains</td>
<td>• Old bread</td>
<td></td>
</tr>
<tr>
<td>• Corn slurry</td>
<td>• Distiller’s grains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Dairy and tofu residues</td>
<td>• Corn slurry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Vinasses and molasses</td>
<td>• Dairy and tofu residues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sugar beet and fruit pulp</td>
<td>• Vinasses and molasses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Potato and fruit cut-offs</td>
<td>• Sugar beet and fruit pulp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Rice and wheat bran</td>
<td>• Potato and fruit cut-offs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Soybean and cocoa hulls</td>
<td>• Rice and wheat bran</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Accepted, if controlled** | | |
| • Supermarket discards | • Old bread | |
| • Hotel, restaurant, food service leftovers | | |

| **Not accepted** | | |
| • Manure | • Slaughterhouse waste | • Household waste |
| • Slaughterhouse waste | | • Sewage |

**Source:** Bühler Insect Technology Solutions
Trends in insect processing

- Black soldier fly: most suitable for feed production

Black soldier fly lifecycle

Eggs → Young larvae → Larvae → Pupae → Adult fly

- Eggs: 4–6 days
- Young larvae: 5–6 days
- Larvae: 5–8 days
- Pupae: 10–14 days
- Adult fly: 3–8 days
Trends in insect processing
- Our role is to provide reliable technology
Trends in insect processing
- Product description and potential applications

**Protein meal**

**Key benefits:** Balanced amino acid profile with very good palatability and digestibility

**Application examples:**
- Hypoallergenic dog food
- High performance fish feed
- Attractant for shrimp feed
- High-growth broiler feed

**Insect lipids**

**Key benefits:** Easy digestible energy with high lauric acid content

**Application examples:**
- High performance piglet feed
- Chicken starter feed
- Cosmetics
- Detergents

**Fertilizer**

**Key benefits:** Slow nutrient release over time with chitin as functional component

**Application examples:**
- Soil improver for home gardens
- Low fertile soil amendment
- High yield crop production
- Biogas production

Source: Bühler Insect Technology Solutions
Larvae processing
- Which route to choose?

Dry rendering  Wet rendering
Larvae processing

Dry rendering
Larvae processing – dry rendering

- Overview

**Classic, straightforward process method**

- Heating and drying
  - Heating indirectly in the cooker / dryer
  - High temperature and long holding time

- Screw press
  - Separating insect meal from effluent

- Decanter
  - Clarifies the lipid fraction
Larvae slurry – dry rendering
- Heating/drying

- Heating indirectly in the cooker/dryer
- High temperature
- Long process time
- High energy consumption

Moisture evaporated and sent to condenser (lipids remain inside)

Raw material inlet

Indirect steam in jacket and rotor

Raw material is conveyed by rotor movement towards outlet
Larvae processing – dry rendering
- Screw press

- Dryer slurry separation by means of filtration
- Press liquid sent for onward processing in the decanter
- Solids leave the outlet as dry press cake

Dry press cake discharge
Press liquid (lipids) passes through screen openings
Dryer slurry is transported and compressed by the rotating screw
Larvae processing – dry rendering
- Decanter

Two-phase decanter
- Centrifugal force separates the press liquid into a clarified lipids and solids
Larvae processing – dry rendering
- Pros and cons

**Upsides**
- Simple technology
- Easily accessible
- Requires relatively low maintenance

**Downsides**
- Lower quality end-products
- Very high energy consumption
- Never hygienic
- Long startup and shutdown time

Over 1,200 kg/h boiler steam for 1,000 kg of evaporated water
Larvae processing

Alfa Laval CentriFlow wet rendering
Larvae processing – Alfa Laval CentriFlow wet rendering
- High quality end-product, low energy consumption
Larvae processing – Alfa Laval CentriFlow wet rendering

- Raw material preparation

Pre-cutting of larvae into puree
Larvae processing

Heating

- Alfa Laval CentriFlow wet rendering
Larvae processing – Alfa Laval CentriFlow wet rendering

- Raw material heating

  - Direct heating (steam injection)
  - Indirect heating
Larvae processing – Alfa Laval CentriFlow wet rendering

- Direct heating (steam injection) of raw materials
Larvae processing – Alfa Laval CentriFlow wet rendering
- Direct heating (steam injection) of raw materials

Upsides
- Final product quality
- High production flexibility
- Compact size
- Low investment cost
- Low cost maintenance

Downsides
- Addition of moisture
- CIP considerations
Larvae processing – Alfa Laval CentriFlow wet rendering
- Indirect heating of raw materials

Raw material heating

- Direct heating (steam injection)
- Indirect heating
Larvae processing – Alfa Laval CentriFlow wet rendering
- Indirect heating of raw materials

Product in

Product out

Condensate outlet

Steam inlet

Contherm scraped surface heat exchanger

Rotating shaft with knives
Larvae processing – Alfa Laval CentriFlow wet rendering

- Indirect heating of raw materials

**Upsides**
- Final product quality
- Hygienic design
- No added moisture
- Compact size

**Downsides**
- Maintenance required
- Risk of fouling
- Investment cost
Larvae processing

Three-phase decanter processing

– Alfa Laval CentriFlow wet rendering
Larvae processing – Alfa Laval CentriFlow wet rendering
- Three-phase decanter processing

• Optimized for insect processing
• Efficient three-phase separation
Larvae processing – Alfa Laval CentriFlow wet rendering
- Three-phase decanter processing

- Three-phase decanter de-waters the solids and separates the stick water and lipid fractions
- Special baffle disc for high dewatering efficiency
- This improves the dewatering process and reduces dryer energy costs
Larvae processing – Alfa Laval CentriFlow wet rendering
- Three-phase decanter processing

• CIP nozzles improve cleanability
  - Bowl exterior
  - Space between the bowl and casing

• CIP inner tube and CIP mode
  - Bowl interior
  - Solids conveyor
  - Outlets
Larvae processing

Purification in centrifugal separator

- Alfa Laval CentriFlow wet rendering
Larvae processing – Alfa Laval CentriFlow wet rendering
- Purification in centrifugal separator

- Purifies the lipids (oil)
- Discharges:
  - Purified lipids or oil through an open oil outlet
  - Sludge through open outlet
  - Stick water by means of gravity disc (pressure)
Larvae processing – Alfa Laval CentriFlow wet rendering
- Purification in centrifugal separator

- Lipids feed
- Rotating disc stack
- Solids discharge
- Sealing water
- Stick water discharge
- Lipids discharge
Larvae processing

Evaporation and concentration

- Alfa Laval CentriFlow wet rendering
Larvae processing – Alfa Laval CentriFlow wet rendering
- Evaporation and concentration
Larvae processing – Alfa Laval CentriFlow wet rendering
- Evaporation and concentration
Larvae processing – Alfa Laval CentriFlow wet rendering
- Evaporation and concentration

Process considerations

Upsides
- Protein recovery
- Energy savings
- Possibility to choose cheapest energy source
Larvae processing – Alfa Laval CentriFlow wet rendering
- Evaporation and concentration

Equipment considerations

**Upsides**
- Higher concentration
- Flexibility
- Extremely compact
- Long running time
- Efficient Cleaning-in-Place (CIP)

**Downsides**
- Gasket replacement
Larvae processing

Drying

- Alfa Laval CentriFlow wet rendering
Larvae processing – Alfa Laval CentriFlow wet rendering

- Drying

• Different dryer technologies can be used

Waste heat reused in case of disc dryer

Decanter solids and stick water concentrate
Larvae processing
- Alfa Laval CentriFlow wet rendering

Individual machines

Complete systems
Larvae processing

Dry rendering vs. wet rendering
Larvae processing
- Dry rendering vs. Alfa Laval CentriFlow wet rendering

**Dry rendering**

**Upsides**
- Simple technology
- Easily accessible technology

**Downsides**
- Lower quality end products
- Very high energy consumption
- Never hygienic
- Long start-up time

**Alfa Laval CentriFlow wet rendering**

**Upsides**
- High quality end products
- Low energy consumption
- Hygienic design
- Quick start-up time
- Flexibility to increase capacity

**Downsides**
- Addition of moisture
- Higher maintenance
Larvae processing
- Dry rendering vs. Alfa Laval CentriFlow wet rendering

Dry rendering

Oil after decanter

Alfa Laval CentriFlow wet rendering

Oil after decanter
Show me the money
- Dry rendering vs. Alfa Laval CentriFlow wet rendering

Dry rendering
- Food-grade protein impossible
- Low protein digestibility and low protein content for the aquafeed industry
- Animal husbandry (poultry, pork) sectors seek lower meal prices

Alfa Laval wet rendering
- Food-grade protein possible
- Aquafeed industry can be interested
- Pet food sector could be interested

With CentriFlow wet rendering, a medium sized BSF rearing operation with 12,500 TPY larvae / 3,000 TPY protein meal production, potentially could increase the revenue by up to MUSD 4 per year.
A strategic partnership
Alfa Laval and Bühler Insect Technology Solutions (BITS)
Alfa Laval and Bühler Insect Technology Solutions
- Best of both worlds

- Knowledge sharing and joint expertise
- Highly flexible, tailored solutions
- Fast ramp-up from pilot-scale to industrial-scale production
- Ongoing collaboration on R&D, marketing and aftersales services
Insect processing plant
- From specific processing unit to complete industrial solution

Feedstock

Live larvae

Fertilizer

Protein meal

Lipids

Source: Bühler Insect Technology Solutions
Q&As